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PREDICTING DIRECT ENERGY TRANSACTION SUBSTITUTION WITH INPUT-OUTPUT MODELS

by

Douglas Kennedy

Bruce Hannon

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Energy Research Group
Office of Vice Chancellor for Research
University of Illinois at Urbana-Champaign
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INTRODUCTION

The structure of Input-Output (I-O) modeling has provided the framework for organizing data into a set of balanced linear equations (see Leontief, 1941). The set of linear equations represents the flow of dollars and energy in the U.S. economy. The goal of this modeling exercise is to generate data which indicates the energy embodied in a dollar's worth of goods or services. The embodied energy is defined as the Energy Intensity, ϵ, (see Hannon et al., April, 1981). Energy I-O modeling accounts for both the direct and indirect energies used to produce goods and service (commodities). Direct energy use is defined as the consumption of an energy commodity, such as electricity or coal, at the commodity production site. The indirect use of energy occurs, for example, when a sheet of steel is used to produce a car. The steel has embodied energy equal to the amount of energy required directly and indirectly to produce it. This embodied energy in the steel used to manufacture a car is now accounted for by I-O modeling as an indirect use of energy.

EXPERIMENTAL DATA BASE DEVELOPEMENT

Data are available to model three years, 1963 (see Herendeen, 1973), 1967 (see Simpson & Smith, 1975) and 1972 (see Blazeck et al., 1981). The Bureau of Economic Analysis (BEA) is the source of the dollar transaction data for the three years. The economic data for 1963 and 1967 were provided at the 368 sector level and at the 365 sector level for 1972. The three year data were formed into a compatible set of 88 sector commodity based constant

dollar transaction matrices (see Kennedy et al., July, 1981).

The data base for each of the three years contains a Make matrix (V), a Use matrix (U), and a Final Demand matrix (FD). The V matrix contains 88 rows which represent 88 industries. Each row contains 88 columns where the dollar value of the various commodities produced by the industry are shown. The U matrix is also 88 by 88, showing the dollar value of the commodities purchased by each industry. The label on each one of the rows represents one of the 88 defined commodities and each industry forms one column of the matrix. The Final Demand matrix shows the dollar value for each of the 88 commodities purchased by 11 different sectors of the economy. The matrice are shown in figure 1.

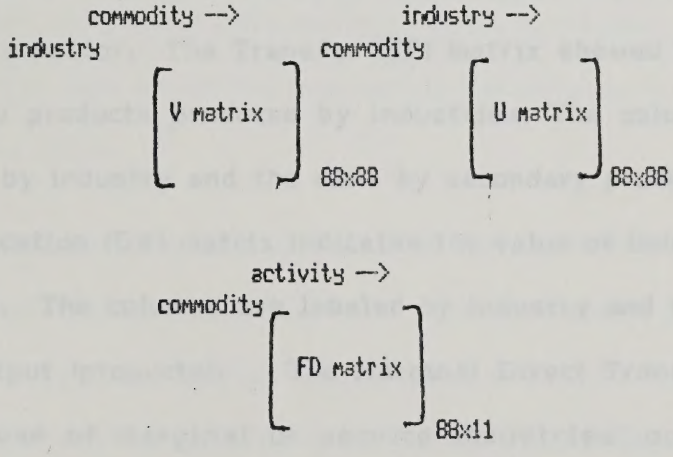
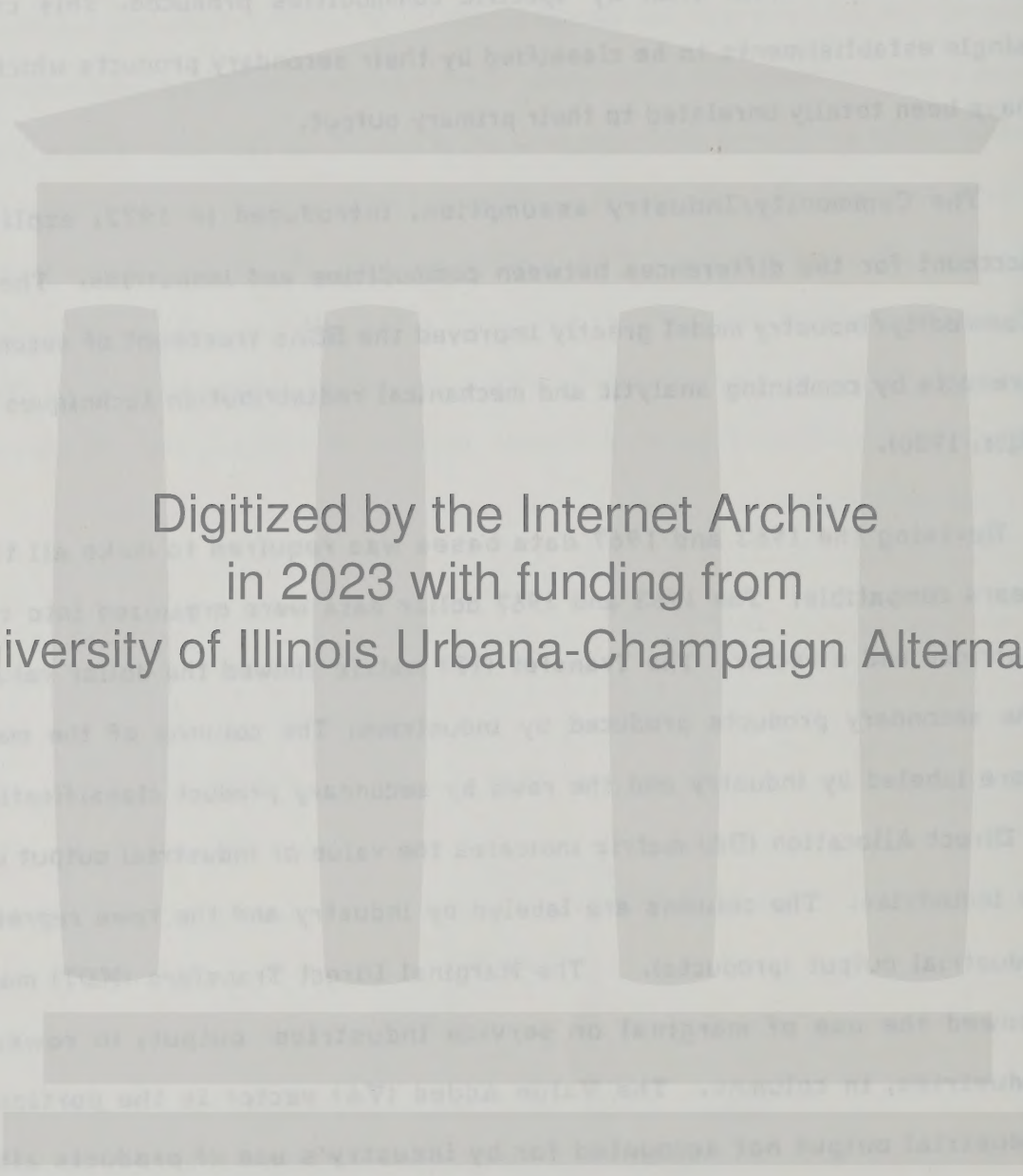


Figure 1. The Use, Make and Final Demand Matrices Format.

Prior to 1972, the dollar transaction data provided by the BEA was industry-based. Sectors in the model were defined as industries, i.e., by establishment rather than by specific commodities produced. This caused single establishments to be classified by their secondary products which may have been totally unrelated to their primary output.

The Commodity/Industry assumption, introduced in 1972, explicitly acccount for the differences between commodities and industries. The new Commodity/Industry model greatly improved the BEAs treatment of secondary products by combining analytic and mechanical redistribution techniques (see Ritz, 1980).

Revising the 1963 and 1967 data bases was required to make all three years compatible. The 1963 and 1967 dollar data were organized into three matrices and a vector. The Transfer (TF) matrix showed the dollar value of the secondary products produced by industries. The columns of the matrix were labeled by industry and the rows by secondary product classifications. A Direct Allocation (DA) matrix indicates the value of industrial output used by industries. The columns are labeled by industry and the rows represent industrial output (products). The Marginal Direct Transfers (MDT) matrix showed the use of marginal or service industries' output, in rows, by industries, in columns. The Value Added (VA) vector is the portion of industrial output not accounted for by industry's use of products alone.



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The analytical process used to transform the 1963 and 1967 matrices to the new form is shown below.

$$DA_{ij} + MDT_{ij} = U_{ij} \qquad (1)$$

$$\sum_{j=1}^{357} TF_{ij} = TSO_i \qquad (2)$$

$$\sum_{i=1}^{357} U_{ij} + VA_j - TSO_j = TPO_j \qquad (3)$$

The Total Primary Output (TPO) vector is diagonalized to form a matrix TPO, then

$$TPO_{ij} + TF_{ij} = V_{ij} \qquad (4)$$

Several other mechanical data redistribution operations were performed to allow the earlier data to fit the new matrix definitions for U, V, and FD (see Kennedy et al., 1981).

The U and FD matrices are modified to include the Energy data in BTUs (British Thermal Units). The first five rows of U and FD are replaced with the Direct Energy Transactions (DET) matrix. The DET indicates the BTU value of each of five energy types used by the industries in the U matrix and Final Demand. The data that makes up the DET was found in various industrial and governmental sources (see Blazeck et al., Sept. 1980).

The following set of equations shows the mathematical development of the I-O model.

$$\sum_{j=1}^{88} U_{ij} + FD_{ij} = q_i \qquad (5)$$

where q_i is the row sum vector which is diagonalized to form a matrix q, the total commodity output. The matrix is inverted and used to form the Market Shares matrix, D, as shown.

$$D = V \; q^{-1} \qquad (6)$$

$$\sum_{j=1}^{88} V_{ij} = g_i \qquad (7)$$

where g_i is the row sum vector which is diagonalized to form a matrix g, total industry output. The matrix is inverted and used to form the Industry Input matrix, B, as shown.

$$B = U \; g^{-1} \qquad (8)$$

The resulting B and D matrices are in mixed units. The energy commodity rows of B are BTU/dollar, while the rest of the matrix is dollar/dollar or unitless. The D matrix units are dollar/BTU for the energy commodity columns, while the rest of the matrix is dollar/dollar or unitless.

The B and D matrices are used in the formulation of the I-O model equation.

$$\epsilon = e(I - BD)^{-1} \qquad (9)$$

where e is a matrix with one's on the diagonals of the energy rows and is otherwise zero.

The model formulation equation (9) produces the following matrix (see figure 2).

Energy Commodities	$\frac{BTU}{BTU}$	$\frac{BTU}{\$}$
Non-Energy Commodities	$\frac{\$}{BTU}$	$\frac{\$}{\$}$

Figure 2. Energy Intensity Matrix.

The top five rows of the above matrix, labeled Energy Commodities, are the Energy Intensities, ϵ, of each of the five energy types used in each industry. The Primary Energy Intensity, ϵ_p, for each industry is calculated by multiplying the Energy Intensity vector for each industry by an α vector (see Kennedy et al., July, 1981). The α_i is the fraction of the direct energy for the particular fuel type i which is taken directly from the U. S. earth by that energy sector. For example, electricity was generated from the primary energy types of coal, crude and natural gas. A factor was formulated to account for the electricity which was generated from the "ground", such as hydro and nuclear power. These quantities were transformed into equivalent fossil fuel units at the average efficiency of the existing fossil fuel power plants. The resulting α vector entry represents the portion of electricity produced from sources other than primary energy inputs.

$$\epsilon_p = \alpha \epsilon \qquad (10)$$

The final result, ϵ_p, is the numerical indicator for the energy cost of producing a dollar's worth of an industry's primary goods or services. The dollar data for 1963 and 1967 has been deflated to 1972 dollar values, so that a true interyear comparison of the ϵ_p can be made. Over time the Energy Intensities have changed, as can be noted in the tables in Appendix 1. As the price and availability of the 5 energy types have changed due to various controllable and uncontrollable events, industry has shifted its use as a response. In this way the model thus far could serve as a measure of the effectiveness of energy policy and rising energy prices.

THE PREDICTIVE ABILITY OF THE I-O MODEL

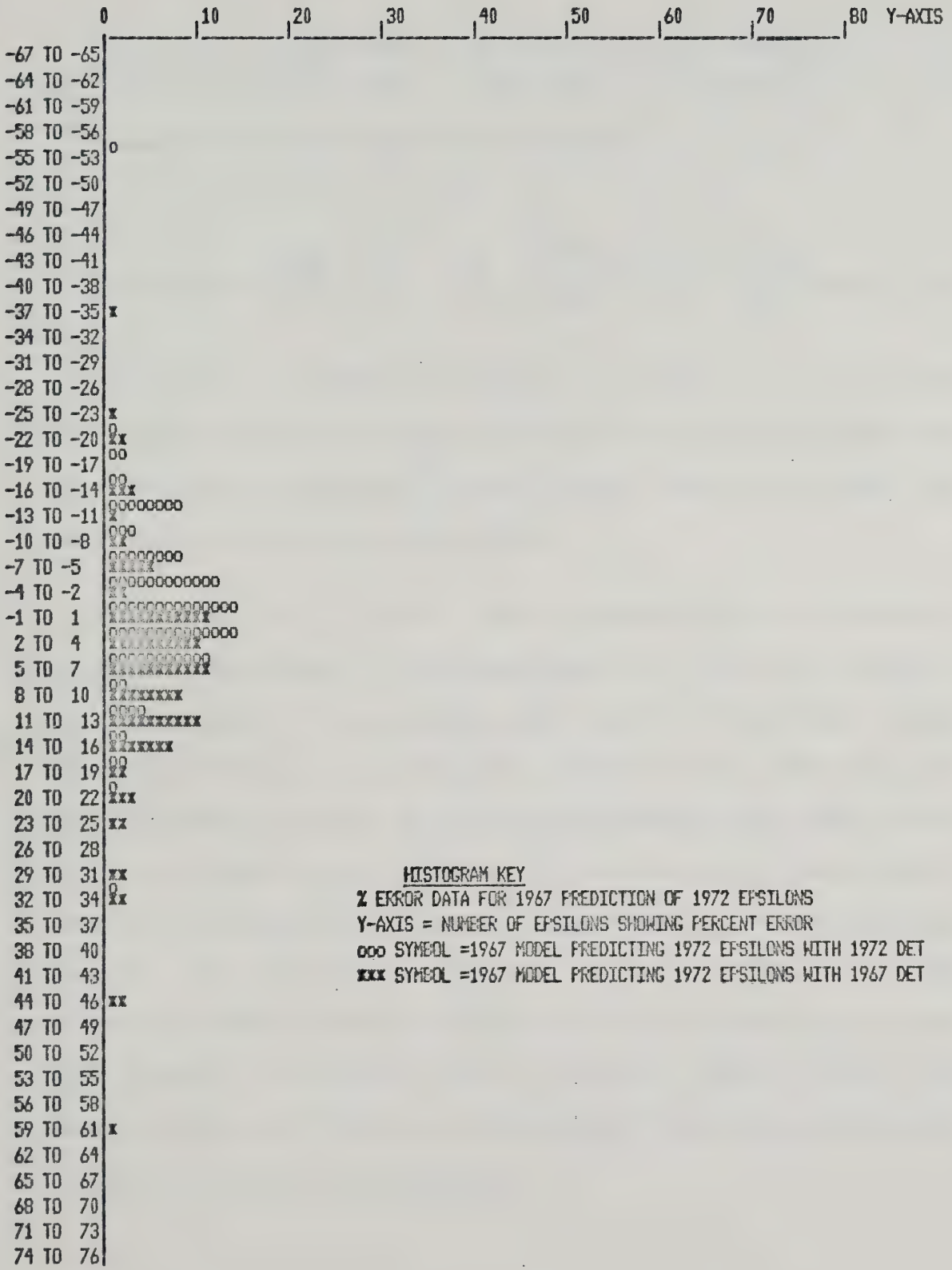
A desirable feature for any model is that it be able to predict the future. In the case of Energy I-O modeling it is desirable that the model be able to predict the present. Predicting the present does not appear to be difficult until it is understood that the data which is required to predict current Energy Intensities will not be available for 5 to 7 years. From this point of view the future is now. The remainder of this document investigates what data is required to allow the model to predict the new accurately.

As a first step the DETs for 1967 and 1972 were substituted for the 1963 DET in the 1963 model, also the 1972 DET was substituted in the 1967 model. The 1963 and 1967 models were then used to calculate the 1967 and 1972 ϵ. These ϵ were then compared to the actual generated for 1967 and 1972. This

operation is referred to as total DET substitution. This is a reasonable procedure in view of the fact that complete DET data is available two or three years before the completion of the full I/O data for the same year. The result of the complete DET substitution is shown on the next three pages in histogram form (Figures 2, 3 and 4). Each of the histograms has two plots. One plot shows the ability of a complete earlier year model to predict the future year. The other plot indicates how well the DET substitution predicts the new ϵ_p data. For example, the first histogram shows the ability of the 1963 data to predict the 1967 ϵ_p and the ability of the 1963 data with the 1967 DET substitution to predict the 1967 ϵ_p. The percent error calculations for both plots on the histograms were performed for each of the 88 sectors as follows:

FIGURE 2. 1963 ERROR DATA HISTOGRAM

FIGURE 3. 1963 ERROR DATA HISTOGRAM


0 10 20 30 40 50 60 70 80 Y-AXIS
-67 TO -65
-64 TO -62
-61 TO -59
-58 TO -56
-55 TO -53
-52 TO -50
-49 TO -47
-46 TO -44
-43 TO -41
-40 TO -38
-37 TO -35
-34 TO -32
-31 TO -29
-28 TO -26
-25 TO -23
-22 TO -20
-19 TO -17
-16 TO -14
-13 TO -11
-10 TO -8
-7 TO -5
-4 TO -2
-1 TO 1
2 TO 4
5 TO 7
8 TO 10
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14 TO 16
17 TO 19
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23 TO 25
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32 TO 34
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38 TO 40
41 TO 43
44 TO 46
47 TO 49
50 TO 52
53 TO 55
56 TO 58
59 TO 61
62 TO 64
65 TO 67
68 TO 70
71 TO 73
74 TO 76
X-AXIS
HISTOGRAM KEY
% ERROR DATA FOR 1967 PREDICTION OF 1972 EPSILONS
Y-AXIS = NUMBER OF EPSILONS SHOWING PERCENT ERROR
ooo SYMBOL =1967 MODEL PREDICTING 1972 EPSILONS WITH 1972 DET
xxx SYMBOL =1967 MODEL PREDICTING 1972 EPSILONS WITH 1967 DET

Figure 4.

$$\% \text{ error} = \text{abs}\left(\left[\epsilon_{p}^{1967}{}_{1967} - \epsilon_{p}^{1963}{}_{1963}\right] / \epsilon_{p}^{1967}{}_{1967}\right) * 100\% \quad (11)$$

abs indicates an absolute value operation

$$\% \text{ error} = \text{abs}\left(\left[\epsilon_{p}^{1967}{}_{1967} - \epsilon_{p}^{1967}{}_{1963}\right] / \epsilon_{p}^{1967}{}_{1967}\right) * 100\% \quad (12)$$

In Equations (11) and (12) the superscript number refers to the year of the DET data and the subscript number indicates the year of the base dollar data. The remaining two histograms, Figures 3 and 4, show data for other year combinations as indicated on the plot keys.

Changing the DET in the I-O model requires that new B matrix be calculated. The B matrix is calculated from the U matrix with the DET in place (see Equation 8) by normalizing the U matrix with the Total Industry Output (g). Obviously it is important to normalize the new DET data with a new Total Industry Output (g) vector, that represents new total industry output for the new energy (DET) data. Obtaining the data to change part of the g vector that normalizes the new DET, appears to require little additional research. New total industry output data is available from the BEA long before the complete transaction matrices are. It was assumed that D matrix, which represents an industry's share of the market, remains constant with change in energy use. Therefore, throughtout the remaining calculations the D matrix is unchanged from the base year.

The total DET substitution experiment proves that substituting complete new DET information does improve the current year model's ability to predict the new Energy Intensity data. Table 1 shows the quantitative effect of the DET substitution in terms of total absolute value percent error for the 88 sectors in the model as shown in the following equation. The total absolute value percent error is given as a measure of goodness as opposed to mean error and standard deviation because of the skewness of the error distribution (see Figures 2, 3, and 4).

$$\text{total \% error} = \sum_{i=1}^{88} (\text{\% error})_i \qquad (13)$$

		YEAR OF DATA USED FOR PREDICTION				
		1963		1967		
		w/o	w/	w/o	w/	<== DET SUBSTITUTION
YEAR TO BE	1967	1083%	479%	---	---	
PREDICTED	1972	1323%	752%	1028%	631%	

Table 1

Considering that both 1963 and 1967 predicted the following years ϵ_p equally as well without DET substitution, it is interesting to note that the 1963 prediction for 1967 with DET substitution produced a better result than 1967's prediction of 1972 with DET substitution. This ability could be due to the change in which the 1972 dollar data was collected and the transaction matrices formed (see Introduction). Although several mechanical data adjustments were performed to make the 1963 and 1967 data compatible to 1972, the original data from the BEA was gathered under the "industry technology" assumption and could still contain inherent differences.

In view of the positive results found for complete DET substitution, it was desirable to determine whether partial DET substitution would provide reasonable results. New DET data for partial substitution may be ready for use in the model 12 to 24 months before the complete DET can be assembled.

MOST IMPORTANT DET PARAMETER ANALYSIS

The Most Important Parameter is essentially a sensitivity analysis of the model. If partial parameter substitution is to be sucessful, it seem reasonable that the parameters that cause the largest change in the resulting should be substituted first.

The Most Important Parameter Analysis, undertaken here, systematically orders the DET parameters in the model according to their effect on the ϵ_p produced. Previous Most Important Parameters (MIP) studies (see Sebald, Nov.,1974, and see Ericson, Sept.,1976) have determined the most important parameters for the dollar, as well as the BTU data. However, due

to the nature of this research, the importance ranking of the BTU data in the DET was done only.

The method of determining the most important DET involves perturbing each DET entry by a fixed percent from the equilibrium state one at a time and noting the effect on the ϵ. The percent perturbation was choosen to corresond to the average percent change in energy use during the period 1967 to 1972. The choice of percent perturbation is important because of the nonlinear nature of the I/O model. It is possible that another choice of percent perturbation could have given different Most Important Parameter ranking, however this phenomena was not investigated.

In order to determine the ranking of the DET entries, each entry was perturbed +30%. The inverse matrix operation shown in Equation 9 was performed to obtain a perturbed set of ϵ_p'. The perturbed ϵ_p' were then compared to the unperturbed set to determine the total absolute value percent change caused by the perturbation. The most important parameter is the DET entry that caused the largest total percent change in the ϵ_p data.

$$\text{MIP \% ranking number} = \sum_{i=1}^{88} \left(\text{abs} \left(\epsilon_{pi} - \epsilon_{pi}' \right) / \epsilon_{pi} \right) * 100\% \qquad (14)$$

The following table lists the 20 most important parameters. However, a more complete list of MIPs is in Appendix 2.

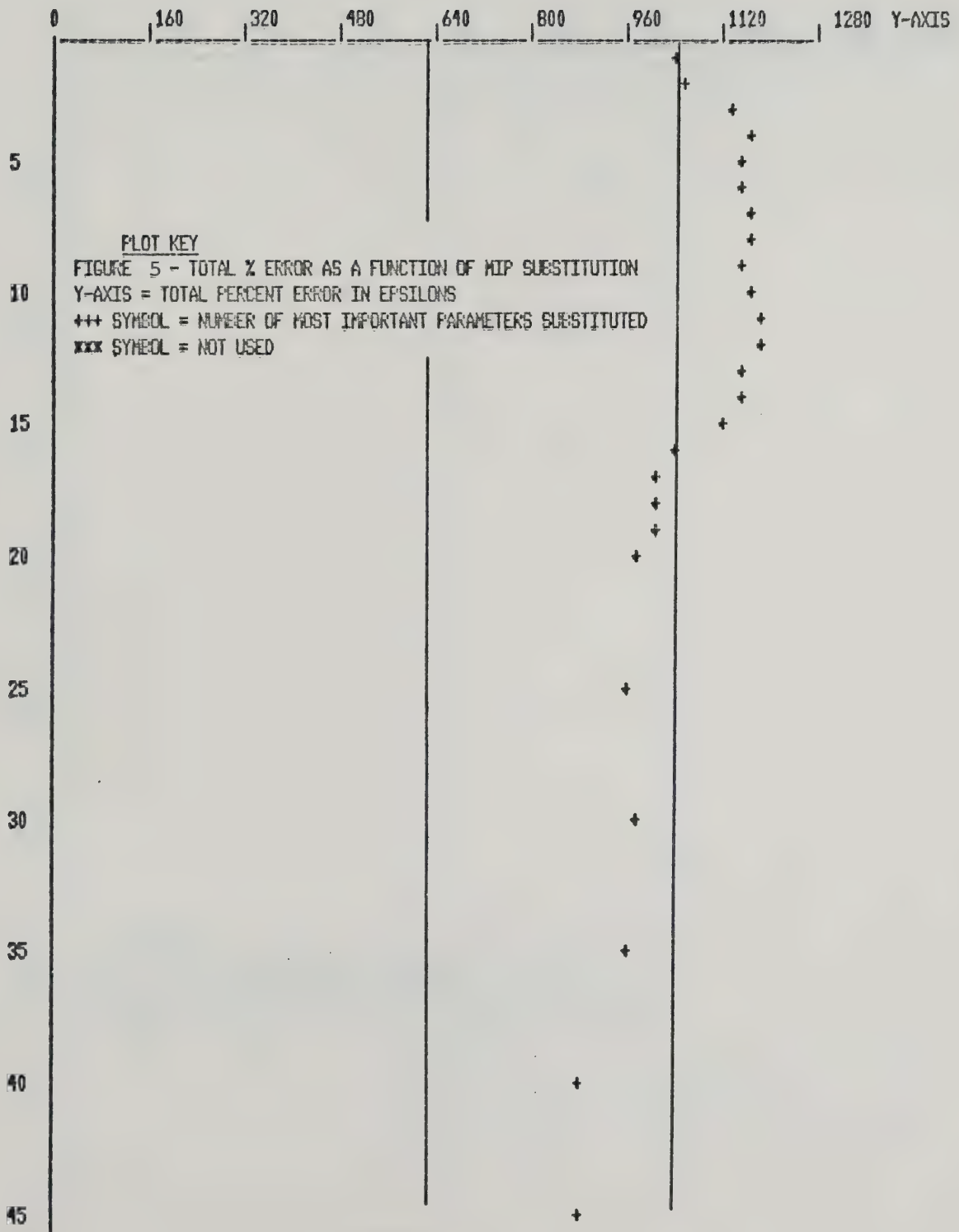
When comparing the MIP analysis ranking to the magnitude of the parameter entry in the DET, there appears to be no direct correspondence. However, a few of the largest magnitude DET entries do appear near the top of the MIP ranking.

MOST IMPORTANT DET ENTRIES (+30% PERTURBATION)

NO.	COMMODITIES PRODUCED	FUEL TYPE USE PERTURBED	TOTAL PERCENT CHANGE (Equation 14)
1	refined petro	crude petro	841%
2	gas utilities	crude petro	813%
3	electricity	coal	340%
4	steel prod.	coal	217%
5	electricity	gas	153%
6	chem prod.	gas	135%
7	steel prod.	gas	93%
8	gas utilities	gas	83%
9	nonferrous prod.	electricity	75%
10	air trans.	refined	73%
11	chem prod.	electricity	73%
12	crude petro	crude petro	71%
13	electricity	electricity	69%
14	refined petro	refined petro	59%
15	steel prod.	refined petro	58%
16	electricity	refined petro	51%
17	railroad	refined petro	49%
18	nonferrous prod.	gas	40%
19	refined petro	gas	40%
20	motor fgt.	refined petro	37%

Table 2
Top 20 Most Important Fuel Uses

The testing of partial DET substitution was implemented by substituting the new most important DET data one entry at a time and recalculating an entire set of ϵ_p. This perturbed set ϵ_p was then compared to the actual ϵ_p and a percent error calculated. The result of substituting the most important parameters in order, one at time, for the first 125 important DET entries is presented in a graph on the next 3 pages (Figure 5). The graph was expected to show that as new DET data was added to the matrix, the resulting ϵ_p approximation would steadily become more correct, approaching the error level of the full DET substitution. This did not occur. When the third most important parameter, the electric industry's use of coal, was substituted, a large increase in the total percent error occurred (see Figure 5). The reason for the large increase is not immediately apparent , especially when we considered the change in the magnitude of the DET parameter substituted. The substitution of this parameter represents only a 15% increase in the electric industry's use of coal. This percent change is average compared to other DET changes. Apparently the single parameter change which the MIP analysis identifies is not the complete reason for a DET entry to be considered critical to the accuracy of the model.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Y-AXIS
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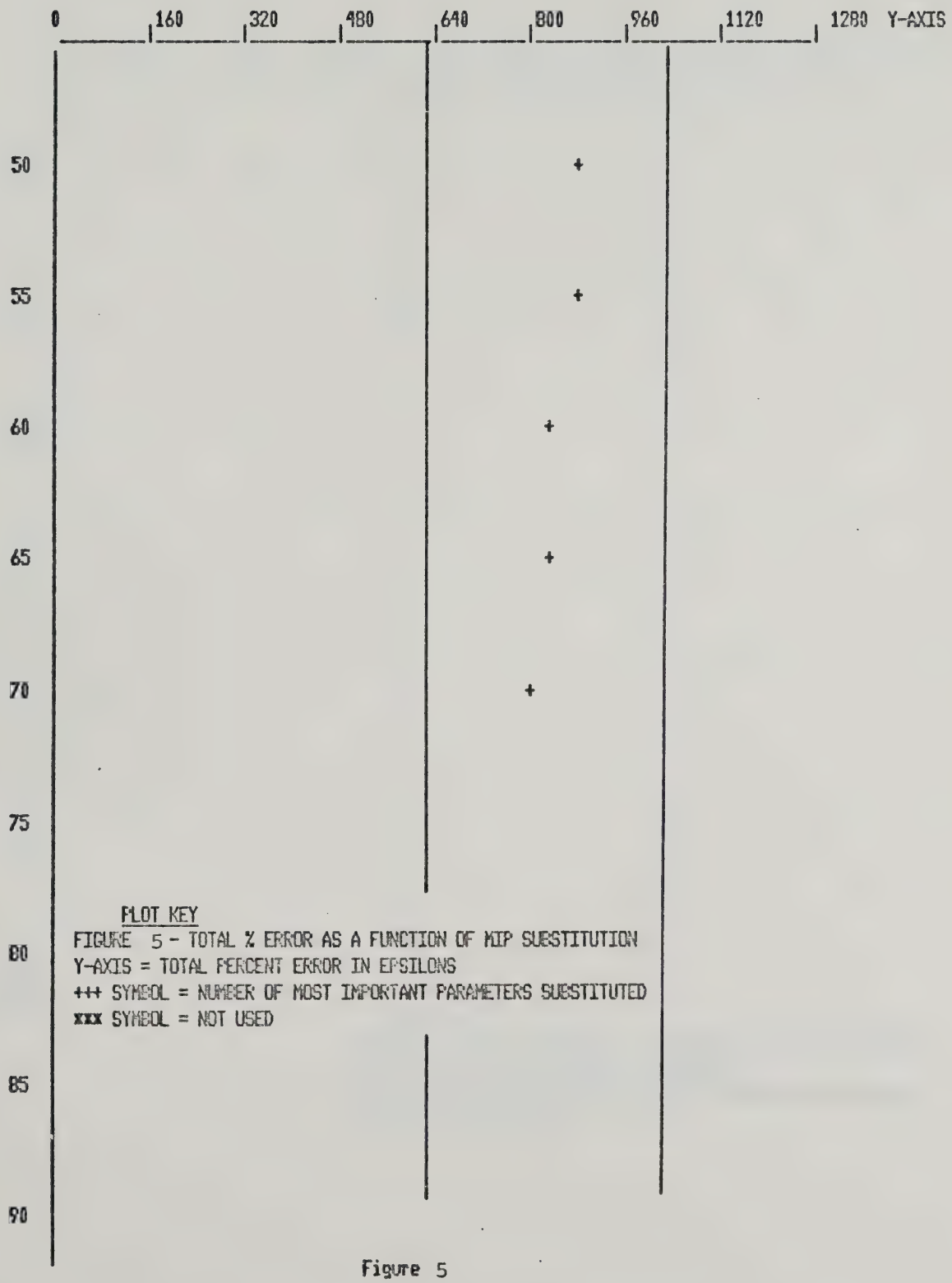
40
45
PLOT KEY
FIGURE 5 - TOTAL % ERROR AS A FUNCTION OF MIP SUBSTITUTION
Y-AXIS = TOTAL PERCENT ERROR IN EPSILONS
+++ SYMBOL = NUMBER OF MOST IMPORTANT PARAMETERS SUBSTITUTED
xxx SYMBOL = NOT USED

Figure 5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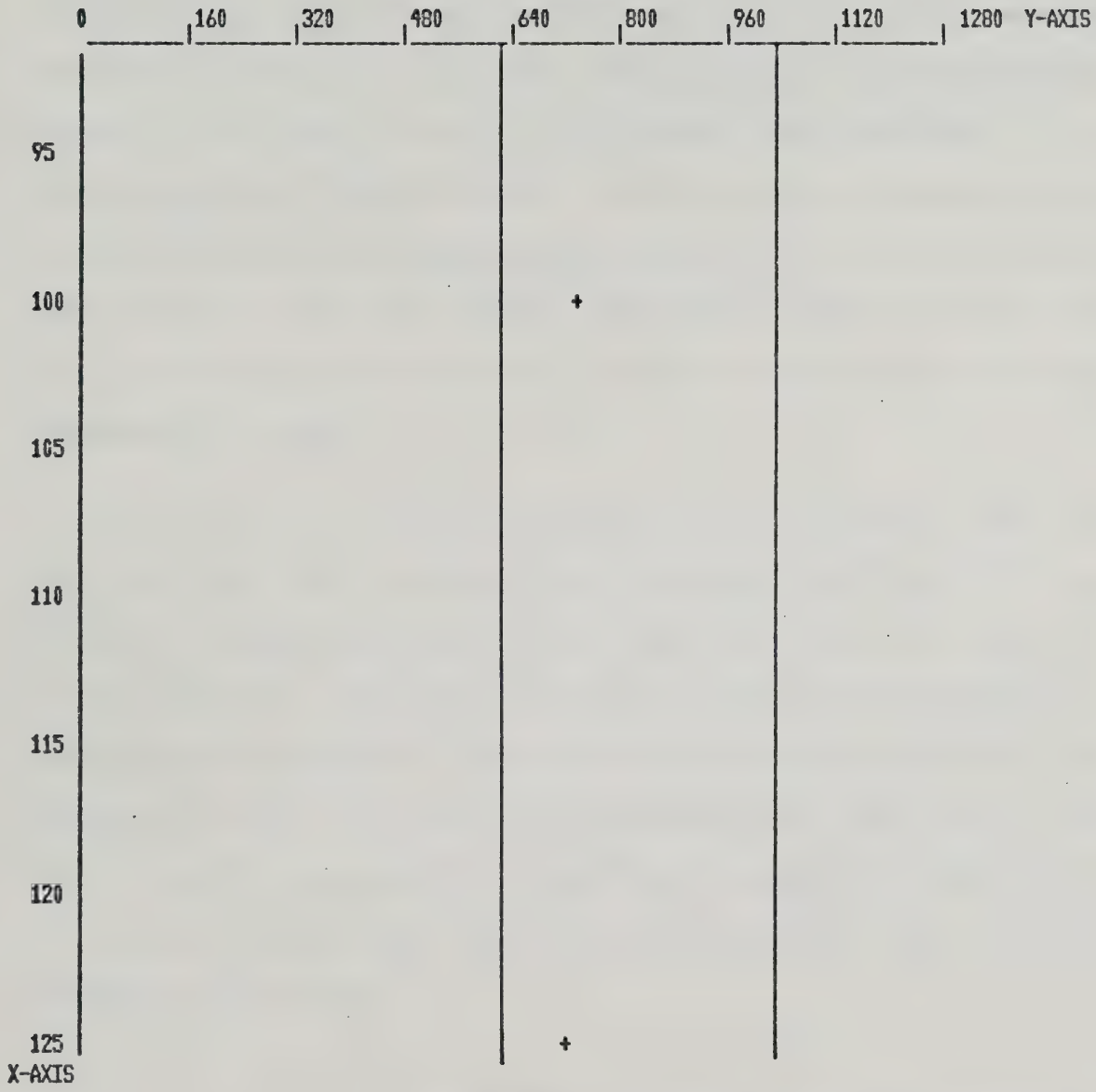

PLOT KEY

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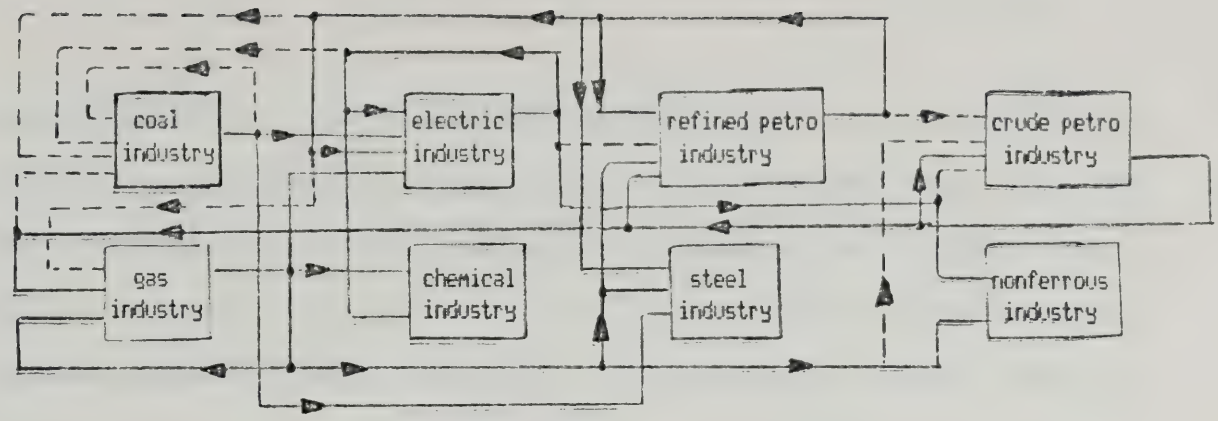
Y-AXIS = TOTAL PERCENT ERROR IN EPSILONS
+++ SYMBOL = NUMBER OF MOST IMPORTANT PARAMETERS SUBSTITUTED
xxx SYMBOL = NOT USED

I-O MODEL FEEDBACK LOOP ANALYSIS

Substituting the first 20 important DET entries in various orders indicated that particular entries had a greater effect on the ϵ_p than the MIP study indicated. This effect forced us to determine the importance of the relationship between the DET entries. Investigating this phenomenon lead us to draw flow diagrams (see Figure 6) and examine critical loops or paths. A critical path being one which indicated a large fuel transfer. A critical path always contains at least one MIP entry. In several cases there are multiple MIP entries in a path.

The MIPs are Energy commodity inputs to various industries. Using the industries of the model as nodes of the flow diagram (see Figure 6), it is possible to visualize the relationship of the MIP inputs to the less important inputs in the model. The diagram shows the five energy producing industries and the three industries that are known to consume large quantities of the various energy types. It is important to remember that the MIP analysis was done for the DET parameters only. Therefore, the effects of feedback paths in the remaining part of the Use matrix were not considered and nonenergy commodities are not shown.



(⟹) path in first 20 MIPs
(⟹) path not in first 20 MIPs

Figure 6. I-O Model Flow Diagram used for viewing Critical Paths

The electric industry's use of electricity was identified to be the thirteenth MIP in the model. However, this "self use" feedback path is more important to the accuracy of the results, than the MIP ranking indicates. To test the parameter's effect as a loop, it was substituted by itself after the other first 19 MIPs were substituted. The total error in the ϵ_p calculation was reduced 19.4%. Other "self use" parameter substitutions showed that all the "self use" parameters are important to the accuracy of the model. The coal industry's use of coal had not been identified as a MIP, but proved to be important when looking at critical paths. Its substitution reduced the error in the ϵ_p calculation 6%, when substituted after the first 20 MIPs.

The effects of unbalancing the sum of the energy inputs to energy industries can have a greater effect on the results than a cursory look would indicate. Consider, for example, the electric industry's use of coal. If this is the only input that changes, as occurred with substituting MIPs one at a time, an increase in the use of coal would increase the energy content of the

electricity produced. Now that a unit of electricity contains more BTUs, the BTU/BTU energy intensity of the electricty output is increased. When the BTU of electricity is used in another energy industry, the BTU/BTU energy intensity of that energy type is increased. When industry uses any energy commodity input, the energy intensity of the commodity produced increases. Clearly, unbalancing the energy input to an energy industry can produce a large error due to interdependence of the models components (commodity producers).

The conclusion of the loop and input balancing analysis is that it is important to substitute the complete energy industries' use of energy portion of the DET at one time. If that cannot be done, as a minimum, each energy industry's use of all energy should be substituted . A key to determine whether a partial DET substitution has worsened an ϵ_p estimation is to look at the resulting change in the energy intensity of the energy commodities. These should remain fairly constant as additional DET substitution is done.

Substituting energy industries' use of energy first does not preclude the fact that the other MIPs in the first 125 group are required to obtain reasonable results. Substituting the energy industries' use of energy merely eliminates and explains the initial increase shown in Figure 6.

A MATHEMATICAL EXAMINATION OF MIP ANALYSIS

MIP analysis performs the following mathematical operation

$$\sum_{j=1}^{440} \sum_{i=1}^{88} {}^{pi}x_j \; x_0$$

where x is the parameter under investigation and x_0 indicates the model at the initial state. The MIP analysis used in this document stops at this point, considering only the effect of a single parameter change on the initial model to determine the most important parameter ranking.

There are other methods of MIP analysis that could be considered. For example,

$$\sum_{j=440-k}^{440} \sum_{i=1}^{88} {}^{pi}x_j \; x_0 + x_k$$

where x_k presents the new initial state caused by the substitution of the previous step's most important parameter. This process could indeed cause parameters that had previous not been identified as MIP to appear earlier in the analysis. Inherent in this process is the recognition that MIP are dependent on the current state of the model. Avoiding the large increase in the total percent error initially shown in Figure 6, could be a result of using this MIP analysis algorithm. However, it is not clear that any additional benefit can be derived. There is a lower limit to the DET substitution percent error, which is the full DET substitution. If indeed this MIP approach could reduce the number of new parameters required for reasonable results, the cost for implementing the algorithm is approximately 200 times

more expensive to run than the simpler form.

CONCLUSIONS

DET substitution is a valid way to get reasonable early estimates of Energy Intensities. The histograms in Figures 2, 3 and 4 show that a few ϵ_p do not predict well. There appears to be a correlation between these intensities and their rate of change over time. Intensities that have exhibited a large change from year to year, such as Iron Mining, Chemical products, and Railroads, are harder to accurately predict. Inaccuracies also occur in industries which are composed of a large number of small firms, such as Agriculture, Forest and Fish Services. The diffuse nature of these industries reduces the accuracy of the data collection process, allowing larger than normal fluctuations in the industries Use data (see Kennedy, et al., 1981).

The ability of the model to provide reasonable results with partial DET substitution is indicative of the damped, closed loop nature of the economy, i.e., a change in the production of one commodity doesn't cause the Gross National Product to become unstable and tend toward infinite. It is imperative that the modeler be alert to large data changes in paths that contain MIP. While the MIP analysis is not the complete solution to the problem of what parameters in the DET must be updated to produce new ϵ_p, it is an extremely useful tool. The ability to reduce the collective percent error in the Energy Intensities produced from 1027% to 703%, by substitution of the first 125 MIPs, speaks well for MIP analysis. It is also important that the modeler substitute complete energy industries' use of energy, as described

earlier.

Further research in this could include looking at different methods of generating the MIPs. The algorithm in mentioned in the mathematical discussion section, which performs parameter substitution during MIP analysis, could serve as a ranking index for a MIP analysis. Using the ranking of the maximum change in one ϵ_p could also be considered. Another area of research would be to investigate the change in the Energy Commodity Energy Intensities, as an indicator of the amount of unbalance a partial DET substitution has caused.

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APPENDIX 1. ENERGY INTENSITY FOR 1963, 1967 AND 1972.

1963 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
1	700	COAL MINING	1.0065	.0062	.0033	.0019	.0028	1.0141
2	800	CRUDE PETRO	.0028	1.0539	.0033	.0011	.0063	1.0578
3	3101	REFINED PETRO	.0132	1.0725	1.0830	.0049	.0590	1.1497
4	6801	ELECTRIC UTIL	1.9710	1.1540	.2820	1.1162	.9022	3.8181
5	6802	GAS UTILITIES	.0059	1.1005	.0098	.0018	1.1109	1.1684
6	100	LIVESTOCK	8021	30817	21885	2541	8420	41849
7	200	AG PROD.	10225	44056	28501	3207	12269	58282
8	300	FOREST PROD.	3571	17139	13582	842	3632	22110
9	400	AG,FOR,FISH SERV.	8762	27330	17735	2133	8516	38706
10	500	IRON MINING	51907	64855	32678	9724	31918	125727
11	600	NONFER MINING	34143	52600	16520	12720	33425	96613
12	900	STONE CLAY MINING	24693	58375	29385	7206	29035	90281
13	1000	CHEM MINERAL MIN	44848	202938	41111	14974	163307	267302
14	1100	NEW CONSTRUCTION	15200	31153	17458	2829	13785	49632
15	1200	MAINT, CONSTRUCT	8920	34184	25145	2004	9441	46116
16	1300	ORDNANCE	15081	19563	8157	3684	10961	37352
17	1400	FOOD	13255	33476	18518	3004	14410	50199
18	1500	TABACCO	6288	14898	8419	1418	5379	22728
19	1600	FABRIC & MILLS	32377	62627	26644	8887	27622	102940
20	1700	TEXTILE GOODS	33348	72791	30377	8472	31660	114261
21	1800	APPAREL	16005	33025	15049	4482	14259	53137
22	1900	FAB TEXTILE PROD	24030	47175	20503	6565	20894	77138
23	2000	WOOD PRODUCTS	9098	23603	12934	2820	10027	35528
24	2100	WOOD CONTAINERS	17768	25646	13205	3529	12304	46778
25	2200	H'HOLD FURNITURE	17514	29606	14121	3879	13617	50803
26	2300	FURN, FIXTURES	24402	30658	12346	3910	17196	58850
27	2400	PAPER PRODUCTS	57992	83833	35462	8142	45959	150811
28	2500	PAPERBOARD CONT	31063	51420	21992	5447	27053	88231
29	2600	PRINTING	14895	27916	12057	3158	13775	45985
30	2700	CHEM PRODUCTS	94936	271867	64099	25840	124185	391468
31	2800	PLASTICS	75845	197906	71807	16433	79834	291203
32	2900	DRUGS	23366	72777	36552	5724	27289	102810
33	3000	PAINTS	30390	94993	44205	7494	35232	133889
34	3102	PAVING	15947	396108	372045	5433	47183	437607
35	3103	ASPHALT	27180	317839	286913	5607	46986	366099
36	3200	RUBBER PRODUCTS	31923	62538	23897	7428	28379	101469
37	3300	LEATHER PRODUCTS	19101	40323	20539	3444	17272	63404
38	3400	FOOTWEAR	12371	24673	11972	2918	10721	39913
39	3500	GLASS PRODUCTS	20156	82449	14698	6116	65723	110412
40	3600	CLAY STONE PROD.	39862	81672	23132	6778	58454	129770
41	3700	PRIM IRON MAN.	116286	70799	27099	7852	43495	195326
42	3800	PRIM NONFER MAN.	40036	72258	22362	16841	49500	125673
43	3900	METAL CONTAINERS	52914	42615	18818	5173	23752	100707
44	4000	HEATING, PLUMBING	42928	41244	16298	6078	24477	89801

APPENDIX 1. CONTINUED
1963 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
45	4100	SCREW MACH PROD.	34765	34627	14025	4791	19948	73928
46	4200	FAB METAL PROD.	35369	41136	15502	5590	23338	81745
47	4300	ENGINES, TURBINES	28711	31669	15905	4310	15863	64523
48	4400	FARM MACHINERY	34175	32746	13345	4021	18982	70929
49	4500	CONST, MINING EQ	32117	29236	19171	4168	17032	65266
50	4600	MAT HANDLING EQ	27073	27264	11626	3870	15126	57936
51	4700	METALWORKING EQ	22021	24704	10676	3694	13781	50127
52	4800	SPEC IND MACH	22810	24961	10704	3620	13860	51138
53	4900	GEN IND MACH	27087	29445	12188	4310	16964	60536
54	5000	MACH SHOP PROD	19685	22755	9507	3657	13098	45722
55	5100	OFC, COMPUTER	13151	19709	9200	3014	10036	35597
56	5200	SERVICE IND MACH	28481	34333	13957	5222	19175	67547
57	5300	ELEC IND APPARAT	24666	31328	11815	5503	18555	60737
58	5400	H'HOLD APPLIANCES	33374	41048	15348	6162	23924	80017
59	5500	ELEC LIGHT EQ	23626	35024	13270	4939	20510	63259
60	5600	R-TV COMMUN EQ	13341	22016	10178	3600	11159	38538
61	5700	ELECTRONIC COMP	24193	42949	17379	6696	23294	73112
62	5800	ELECTRICAL EQ	20527	31216	10895	5499	18225	56415
63	5900	MOTOR VEH & EQ	31401	31883	13105	4607	18029	67562
64	6000	AIRCRAFT & PARTS	14818	20643	9304	3868	11079	38741
65	6100	TRANSPORT EQUIP	32199	32960	14510	4651	17979	69534
66	6200	PROF SCIENCE SUP	15796	23568	9775	3685	12784	42659
67	6300	OPTICAL SUPPLIES	22386	41412	16112	4686	19661	68371
68	6400	MISC MANUFACTURE	19595	35059	16088	4367	16484	58873
69	6501	RAILROADS	9937	60808	55296	1467	8617	75002
70	6502	LOCAL TRANSPORT	6486	48190	42914	2874	7747	59015
71	6503	MOTOR FGT TRANSP	2911	31983	28676	1073	4799	37295
72	6504	WATER TRANSPORT	10041	139806	136189	2000	12056	158924
73	6505	AIR TRANSPORT	4378	128032	124667	1549	11074	140562
74	6506	PIPE LINE TRANS	12176	150599	37975	5995	64917	171716
75	6507	TRANSP SERVICES	3472	22192	17769	1622	5462	27827
76	6600	COMMUNICATIONS	3698	13228	8329	1686	5310	18610
77	6700	R-TV BROADCAST	3630	10400	5196	1657	5242	15527
78	6803	WATER,SANIT SER	15001	51412	31387	4018	20738	71486
79	6900	WHOLE,RETAIL TR	4741	17884	11233	1925	7118	24674
80	7000	FINANCE SER	4378	12756	6178	1874	6781	18875
81	7100	REAL ESTATE	2686	8944	5513	797	3251	12551
82	7200	HOTEL,PERS SER	5673	20830	11859	1954	8875	28772
83	7300	BUSINESS SERVICE	6180	16247	8066	1984	7792	24381
84	7500	AUTO REPAIR	6417	15601	8669	1669	6855	23795
85	7600	AMUSEMENTS	4293	13269	6698	1685	6089	19201
86	7700	MED, EDUC SER	5543	15536	8003	2557	7697	23367
87	7800	FED GOVT ENTERP	2428	12139	8254	906	4301	15752
88	7900	ST,LOCAL GOVT ENT	11353	28412	12945	4921	14905	44042

APPENDIX 1. CONTINUED
1967 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
1	700	COAL MINING	1.0048	.0055	.0025	.0018	.0028	1.0116
2	800	CRUDE PETRO	.0034	1.0515	.0024	.0013	.0095	1.0564
3	3101	REFINED PETRO	.0128	1.0417	1.0700	.0051	.0632	1.1192
4	6801	ELECTRIC UTIL	1.9254	1.1191	.3063	1.1096	.8622	3.7542
5	6802	GAS UTILITIES	.0060	1.0730	.0049	.0020	1.1039	1.1515
6	100	LIVESTOCK	7247	37157	26146	2294	10102	47783
7	200	AG PROD.	9364	50677	28521	3074	16154	64387
8	300	FOREST PROD.	3515	26877	22596	913	5057	32462
9	400	AG,FOR,FISH SERV.	5445	20914	11481	1426	7656	28292
10	500	IRON MINING	31383	74725	18738	13061	55730	118213
11	600	NONFER MINING	34195	54528	18727	14047	33420	99960
12	900	STONE CLAY MINING	23177	57596	24671	7012	33285	88278
13	1000	CHEM MINERAL MIN	38802	188585	21371	17480	170083	249536
14	1100	NEW CONSTRUCTION	13169	34072	20386	2798	14516	50884
15	1200	MAINT, CONSTRUCT	8330	27405	18149	1781	9661	38361
16	1300	ORDNANCE	17356	26875	10114	4291	14893	48202
17	1400	FOOD	11865	35616	17895	3196	16785	51368
18	1500	TABACCO	6331	18793	9452	1636	7341	27047
19	1600	FABRIC & MILLS	28330	60083	20563	8942	30556	96630
20	1700	TEXTILE GOODS	26623	68724	23915	7485	33920	103123
21	1800	APPAREL	14545	32438	12265	4682	16122	51374
22	1900	FAB TEXTILE PROD	21353	44242	15370	6287	23331	71540
23	2000	WOOD PRODUCTS	9574	30796	15261	3363	15037	44095
24	2100	WOOD CONTAINERS	9483	25858	12232	3169	13372	38684
25	2200	H'HOLD FURNITURE	14503	27505	11177	3855	14742	45776
26	2300	FURN, FIXTURES	20131	27899	9494	3795	17505	51851
27	2400	PAPER PRODUCTS	46505	86521	34298	9195	50010	143382
28	2500	PAPERBOARD CONT	25400	54509	21073	5933	30795	86438
29	2600	PRINTING	12321	27147	10274	3242	14955	42848
30	2700	CHEM PRODUCTS	65215	267913	33559	20139	135757	355253
31	2800	PLASTICS	63057	177416	51648	14033	83507	256702
32	2900	DRUGS	17476	52774	14233	4887	27983	75627
33	3000	PAINTS	25069	87928	25939	6928	42342	121105
34	3102	PAVING	38279	377088	350100	5141	57126	440895
35	3103	ASPHALT	21836	306590	274035	5036	50556	349364
36	3200	RUBBER PRODUCTS	26508	58577	17967	6967	30627	92030
37	3300	LEATHER PRODUCTS	14850	37316	15936	3309	17031	56024
38	3400	FOOTWEAR	11272	25531	10288	3121	12826	39978
39	3500	GLASS PRODUCTS	15766	72296	10764	5999	61254	96034
40	3600	CLAY STONE PROD.	43275	82772	22091	6915	61476	135121
41	3700	PRIM IRON MAN.	98250	65724	17542	9003	48575	173222
42	3800	PRIM NONFER MAN.	43563	70208	18963	18744	51459	128880
43	3900	METAL CONTAINERS	43698	42246	12929	5899	29252	92110
44	4000	HEATING, PLUMBING	36533	38433	11753	5875	26857	80717

APPENDIX 1. CONTINUED
1967 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
45	4100	SCREW MACH PROD.	34721	32587	9932	5539	22603	72482
46	4200	FAB METAL PROD.	31141	38316	12173	5535	24530	74874
47	4300	ENGINES, TURBINES	25796	28259	10484	4826	18028	58556
48	4400	FARM MACHINERY	29662	29597	9382	4339	20170	63558
49	4500	CONST, MINING EQ	27595	27551	9037	4359	18701	59701
50	4600	MAT HANDLING EQ	23252	25956	8284	3986	16737	52005
51	4700	METALWORKING EQ	19635	23203	7771	3905	15433	46495
52	4800	SPEC IND MACH	19712	23154	8607	3717	14689	46413
53	4900	GEN IND MACH	23580	26988	9063	4457	18052	54781
54	5000	MACH SHOP PROD	16925	21176	6890	3793	14399	41579
55	5100	OFC, COMPUTER	12546	20398	8315	3524	11737	36174
56	5200	SERVICE IND MACH	23719	31237	10444	5110	20263	59761
57	5300	ELEC IND APPARAT	20518	26461	9301	5425	18474	53788
58	5400	H'HOLD APPLIANCES	26795	35938	11444	5732	23226	68140
59	5500	ELEC LIGHT EQ	20251	30669	9265	4922	20474	55567
60	5600	R-TV COMMUN EQ	10866	18443	6875	3450	11004	32370
61	5700	ELECTRONIC COMP	17744	33248	10631	5795	20566	56221
62	5800	ELECTRICAL EQ	19111	32330	9601	5680	20301	56531
63	5900	MOTOR VEH & EQ	25336	28665	9491	4683	18697	58408
64	6000	AIRCRAFT & PARTS	13527	18967	7051	3917	11867	35890
65	6100	TRANSPORT EQUIP	25328	29235	10786	4616	18356	58979
66	6200	PROF SCIENCE SUP	14409	24244	8966	3765	14343	42223
67	6300	OPTICAL SUPPLIES	13178	33452	9955	4261	18393	50800
68	6400	MISC MANUFACTURE	16406	30744	11192	4291	17244	51330
69	6501	RAILROADS	7252	47860	43483	1272	7569	58677
70	6502	LOCAL TRANSPORT	6282	37358	33323	2746	6559	47440
71	6503	MOTOR FGT TRANSP	2997	26361	24180	752	3922	31347
72	6504	WATER TRANSPORT	12263	145512	137796	2872	15790	164880
73	6505	AIR TRANSPORT	4350	126125	125636	1514	10893	138827
74	6506	PIPE LINE TRANS	22019	100597	28819	11225	31718	132665
75	6507	TRANSP SERVICES	2208	3167	1620	480	1556	5838
76	6600	COMMUNICATIONS	2980	10299	6627	1273	4045	14559
77	6700	R-TV BROADCAST	5899	13513	6041	2684	7732	21778
78	6803	WATER,SANIT SER	17367	34451	12670	4378	21781	56421
79	6900	WHOLE,RETAIL TR	5181	18507	11774	2293	7517	26126
80	7000	FINANCE SER	3597	10521	5937	1464	4877	15594
81	7100	REAL ESTATE	2484	8443	5081	798	3285	11871
82	7200	HOTEL,PERS SER	8646	27875	17332	3066	11112	39934
83	7300	BUSINESS SERVICE	5078	15965	7850	1514	7846	22842
84	7500	AUTO REPAIR	8218	23178	15959	2231	8035	34057
85	7600	AMUSEMENTS	4387	14157	7743	1890	6252	10451
86	7700	MED, EDUC SER	8215	18851	8496	3660	10733	30319
87	7800	FED GOVT ENTERP	3162	18227	13566	1387	5765	23289
88	7900	ST,LOCAL GOVT ENT	11632	30173	14364	4576	15380	46198

APPENDIX 1. CONTINUED
1972 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
1	700	COAL MINING	1.0101	.0104	.0065	.0027	.0041	1.0227
2	800	CRUDE PETRO	.0028	1.0556	.0056	.0016	.0065	1.0601
3	3101	REFINED PETRO	.0109	1.0622	1.0791	.0063	.0607	1.1478
4	6801	ELECTRIC UTIL	1.5750	1.4465	.6288	1.1307	.8937	3.7714
5	6802	GAS UTILITIES	.0046	1.0663	.0086	.0027	1.1022	1.1497
6	100	LIVESTOCK	7297	40296	25292	3871	14099	52381
7	200	AG PROD.	8399	61468	35607	4433	21936	76170
8	300	FOREST PROD.	5730	68746	59015	2288	11925	80323
9	400	AG,FOR,FISH SERV.	7024	39880	22946	3556	15553	51465
10	500	IRON MINING	41540	92965	26578	16569	68897	150467
11	600	NONFER MINING	24912	61233	28302	14668	32726	98608
12	900	STONE CLAY MINING	20368	76335	47542	8912	31764	107007
13	1000	CHEM MINERAL MIN	32425	260195	55911	17357	179315	284364
14	1100	NEW CONSTRUCTION	11878	42274	27088	3585	16326	59045
15	1200	MAINT, CONSTRUCT	7222	45595	35209	2429	11734	57237
16	1300	ORDNANCE	13755	25810	10367	4886	15621	44103
17	1400	FOOD	9784	40200	19739	4173	20165	55019
18	1500	TABACCO	4703	21548	12265	2088	8571	28851
19	1600	FABRIC & MILLS	23090	77510	32083	10611	38703	111390
20	1700	TEXTILE GOODS	18939	76348	31664	8469	38040	104779
21	1800	APPAREL	12045	42221	18565	5896	21083	60264
22	1900	FAB TEXTILE PROD	15916	51613	22103	7170	25859	74826
23	2000	WOOD PRODUCTS	10488	45279	24467	5173	21270	62108
24	2100	WOOD CONTAINERS	12381	40250	19484	5121	21829	58309
25	2200	H'HOLD FURNITURE	12981	35074	16085	4931	18256	53112
26	2300	FURN, FIXTURES	17698	37541	14795	4925	22584	60563
27	2400	PAPER PRODUCTS	31552	103118	48556	10620	55148	147645
28	2500	PAPERBOARD CONT	18556	64962	30492	6967	33971	91791
29	2600	PRINTING	9662	34494	15965	4132	17062	48778
30	2700	CHEM PRODUCTS	37794	250001	60320	14990	121875	302658
31	2800	PLASTICS	35252	171356	67472	12595	80320	223654
32	2900	DRUGS	11030	48779	18081	4441	24342	65184
33	3000	PAINTS	18060	100740	38174	7092	45062	128399
34	3102	PAVING	23757	382488	359068	6485	48644	435879
35	3103	ASPHALT	14110	374188	343007	6234	52622	417005
36	3200	RUBBER PRODUCTS	18309	66271	25825	7685	33814	92960
37	3300	LEATHER PRODUCTS	13558	58619	25404	5042	29029	78682
38	3400	FOOTWEAR	10024	35737	15703	4384	17962	50510
39	3500	GLASS PRODUCTS	14197	86070	16829	7528	70119	110519
40	3600	CLAY STONE PROD.	32623	94109	32591	8254	63173	137906
41	3700	PRIM IRON MAN.	94198	78017	26852	15303	51922	184128
42	3800	PRIM NONFER MAN.	39188	88877	30977	21893	59181	146678
43	3900	METAL CONTAINERS	40129	56042	21812	8291	34572	104699
44	4000	HEATING, PLUMBING	32498	45606	17332	7265	28864	85366

APPENDIX 1, CONTINUED
1972 ENERGY INTENSITIES

	IOCODE	SECTOR	COAL	CRUDE	REFINED	ELECTRIC	GAS	PRIMARY
45	4100	SCREW MACH PROD.	33848	42397	15709	7228	27010	83255
46	4200	FAB METAL PROD.	28347	45655	16518	7126	28890	81134
47	4300	ENGINES, TURBINES	23119	32193	12953	5710	19841	60780
48	4400	FARM MACHINERY	23532	32708	12026	4902	21060	61272
49	4500	CONST, MINING EQ	23808	31442	11403	5181	20490	60362
50	4600	MAT HANDLING EQ	21418	31538	12161	5010	19828	57971
51	4700	METALWORKING EQ	17955	28341	10643	4989	18052	51053
52	4800	SPEC IND MACH	17774	32914	12941	3499	11934	55711
53	4900	GEN IND MACH	21732	32957	12367	5567	21162	60129
54	5000	MACH SHOP PROD	18002	30721	11514	5412	19635	53914
55	5100	OFC, COMPUTER	10532	23696	10575	4370	13194	38315
56	5200	SERVICE IND MACH	19114	33497	12678	5739	20937	58144
57	5300	ELEC IND APPARAT	17874	33767	13207	6496	20657	57631
58	5400	H'HOLD APPLIANCES	19853	33729	11391	5588	22690	66298
59	5500	ELEC LIGHT EQ	17226	35918	13293	5813	22175	58855
60	5600	R-TV COMMUN EQ	9701	22752	9706	4389	13064	36488
61	5700	ELECTRONIC COMP	12803	32281	13129	6034	18540	50652
62	5800	ELECTRICAL EQ	16481	37392	14133	6792	22075	60190
63	5900	MOTOR VEH & EQ	21130	33429	13157	5414	20202	59894
64	6000	AIRCRAFT & PARTS	11974	23917	10478	4986	13805	40368
65	6100	TRANSPORT EQUIP	19551	35089	15190	5280	20045	60073
66	6200	PROF SCIENCE SUP	11428	27724	11569	4556	15507	43091
67	6300	OPTICAL SUPPLIES	12441	30912	12104	3824	16257	47436
68	6400	MISC MANUFACTURE	14147	39292	16973	5602	21315	59199
69	6501	RAILROADS	5180	62910	57157	1735	9516	73337
70	6502	LOCAL TRANSPORT	5312	35991	29236	2711	8394	45277
71	6503	MOTOR FGT TRANSP	2175	35656	33127	1037	4631	40828
72	6504	WATER TRANSPORT	18725	158529	153290	3964	15940	180262
73	6505	AIR TRANSPORT	3607	124813	122449	1957	10890	137990
74	6506	PIPE LINE TRANS	12754	89077	30918	18524	26114	110476
75	6507	TRANSP SERVICES	1744	8013	4988	947	3249	10839
76	6600	COMMUNICATIONS	2445	16877	4335	1509	2792	10653
77	6700	R-TV BROADCAST	5526	14778	8412	3661	6895	23411
78	6803	WATER,SANIT SER	16872	36023	23935	2823	12498	46886
79	6900	WHOLE,RETAIL TR	3145	11834	17504	1924	4790	16886
80	7000	FINANCE SER	1732	6765	4015	1985	2944	9518
81	7100	REAL ESTATE	7325	25979	14298	4004	12078	37338
82	7200	HOTEL,PERS SER	3930	15702	19040	1904	16726	21759
83	7300	BUSINESS SERVICE	9251	21086	9931	3243	11333	33608
84	7500	AUTO REPAIR	4406	17070	19241	2713	8078	24173
85	7600	AMUSEMENTS	5889	12092	10064	3475	11178	30221
86	7700	MED, EDUC SER	2716	17279	11020	1652	7087	22127
87	7800	FED GOVT ENTERP	6940	38824	22023	2489	16332	50203
88	7900	ST,LOCAL GOVT ENT	11632	30173	14364	4576	15380	46198

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
1	2	3	841.69
2	2	5	813.54
3	1	4	340.61
4	1	41	217.53
5	5	4	153.40
6	5	30	135.87
7	5	41	93.16
8	5	5	83.15
9	4	42	75.35
10	3	73	73.84
11	4	30	73.49
12	2	2	70.99
13	4	4	69.51
14	3	3	59.92
15	4	41	58.81
16	3	4	51.34
17	3	69	49.84
18	5	42	40.80
19	5	3	40.68
20	3	71	37.72
21	3	7	37.23
22	3	72	36.35
23	5	27	35.56
24	3	79	34.50
25	3	35	33.29
26	3	34	31.78
27	1	30	30.76
28	1	27	30.18
29	5	40	29.42
30	3	27	27.26
31	5	39	26.62
32	5	13	25.64
33	4	27	25.02
34	3	70	24.18
35	3	41	24.05

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
36	3	31	23.93
37	4	79	23.17
38	3	8	22.43
39	3	6	19.21
40	3	15	19.12
41	4	19	18.95
42	4	11	18.44
43	1	31	17.81
44	3	30	16.20
45	1	40	16.16
46	3	84	15.52
47	5	10	15.22
48	4	10	14.65
49	4	88	14.39
50	3	82	13.59
51	5	79	13.12
52	5	31	13.02
53	5	2	12.21
54	4	86	12.11
55	4	23	11.86
56	3	83	11.78
57	3	76	11.62
58	2	74	11.56
59	5	23	11.24
60	3	23	11.10
61	4	31	11.02
62	4	36	10.22
63	3	42	10.18
64	3	87	9.92
65	4	77	9.86
66	4	40	9.65
67	5	83	9.58
68	4	74	9.28
69	4	80	9.20
70	4	13	8.67

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
71	5	12	8.62
72	3	88	8.38
73	5	88	8.33
74	4	76	8.31
75	4	12	8.24
76	5	17	8.21
77	4	85	8.18
78	4	61	8.13
79	2	30	8.02
80	3	12	7.70
81	4	39	7.60
82	3	80	7.25
83	4	3	7.19
84	4	82	7.01
85	4	57	6.88
86	3	40	6.81
87	5	86	6.66
88	5	78	6.63
89	3	81	6.59
90	1	42	6.54
91	3	14	6.37
92	5	19	6.18
93	3	74	6.12
94	4	87	6.09
95	5	11	5.77
96	4	64	5.70
97	4	54	5.63
98	4	17	5.57
99	4	45	5.52
100	1	19	5.49
101	5	46	5.49
102	4	70	5.46
103	5	87	5.44
104	4	2	5.44
105	1	75	5.41

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
106	4	29	5.40
107	3	86	5.35
108	4	46	5.25
109	5	74	5.23
110	5	77	5.23
111	5	36	5.22
112	3	85	5.10
113	5	80	4.97
114	3	19	4.91
115	3	11	4.79
116	1	36	4.78
117	5	82	4.61
118	3	37	4.57
119	5	76	4.46
120	3	33	4.43
121	5	85	4.22
122	4	53	4.18
123	3	46	4.17
124	4	51	4.17
125	4	60	4.12
126	4	75	4.03
127	1	78	3.99
128	4	1	3.96
129	4	63	3.94
130	5	54	3.90
131	3	10	3.85
132	1	37	3.83
133	4	81	3.82
134	4	7	3.74
135	5	28	3.50
136	4	83	3.46
137	3	17	3.40
138	5	44	3.39
139	4	28	3.35
140	1	17	3.27

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
141	4	16	3.25
142	4	20	3.23
143	5	45	3.20
144	4	59	3.20
145	4	24	3.18
146	4	84	3.14
147	4	49	3.12
148	5	53	3.10
149	4	62	3.10
150	5	29	3.09
151	5	57	3.02
152	3	36	3.00
153	4	78	2.96
154	4	55	2.94
155	5	61	2.79
156	5	51	2.79
157	4	6	2.77
158	4	58	2.75
159	4	44	2.72
160	5	34	2.71
161	3	9	2.69
162	1	69	2.67
163	4	47	2.63
164	5	24	2.63
165	4	25	2.62
166	5	20	2.59
167	5	35	2.57
168	4	68	2.53
169	5	59	2.49
170	4	66	2.47
171	1	34	2.41
172	4	37	2.41
173	3	20	2.38
174	5	43	2.37
175	3	28	2.34

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
176	5	49	2.33
177	5	63	2.28
178	4	67	2.28
179	4	52	2.27
180	3	16	2.26
181	1	12	2.24
182	5	37	2.19
183	5	58	2.15
184	4	21	2.14
185	5	48	2.09
186	4	65	2.09
187	1	63	2.05
188	5	64	2.04
189	3	13	1.96
190	3	39	1.94
191	5	26	1.92
192	3	47	1.90
193	4	38	1.90
194	4	43	1.89
195	4	26	1.87
196	1	88	1.84
197	1	48	1.83
198	5	62	1.83
199	5	81	1.82
200	3	29	1.79
201	4	56	1.76
202	5	33	1.74
203	5	69	1.74
204	3	32	1.74
205	5	75	1.69
206	3	67	1.69
207	4	32	1.69
208	1	45	1.68
209	1	47	1.62
210	1	18	1.60

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
211	5	66	1.59
212	4	18	1.59
213	3	53	1.57
214	4	48	1.55
215	3	61	1.54
216	5	32	1.52
217	1	71	1.49
218	1	23	1.48
219	3	24	1.47
220	3	54	1.47
221	5	56	1.46
222	1	82	1.44
223	3	45	1.43
224	5	68	1.43
225	4	50	1.42
226	1	49	1.42
227	5	52	1.41
228	3	78	1.40
229	3	51	1.40
230	1	11	1.38
231	4	22	1.37
232	3	52	1.37
233	4	69	1.36
234	1	46	1.36
235	5	47	1.35
236	3	2	1.32
237	5	60	1.32
238	5	50	1.29
239	3	68	1.28
240	1	58	1.28
241	4	33	1.26
242	5	22	1.24
243	3	65	1.21
244	3	49	1.16
245	3	64	1.16

APPENDIX 2
MIP RANKING LIST

#	ROW	COLUMN	PERCENT ERROR
246	4	5	1.16
247	3	1	1.16
248	1	86	1.13
249	1	39	1.13
250	5	67	1.13
251	3	57	1.13
252	3	66	1.12
253	1	53	1.11
254	5	38	1.08
255	5	65	1.08
256	1	6	1.08
257	1	57	1.07
258	1	32	1.04
259	3	60	1.02
260	3	21	1.02
261	3	44	1.00
262	5	55	1.00
263	5	25	.99
264	1	20	.99
265	1	3	.99
266	1	9	.97
267	1	16	.96
268	5	71	.96
269	1	25	.95
270	5	16	.93
271	3	62	.93
272	1	22	.93
273	3	38	.93
274	3	59	.92
275	3	5	.89
276	3	25	.89
277	1	77	.87
278	1	5	.87
279	5	9	.87
280	1	62	.87

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